CLAIMS

WHAT IS CLAIMED:

1. A method of analyzing traces collected along a plurality of sail lines in a marine seismic survey area, comprising:

selecting a plurality of trace groups, each trace having an offset from a midpoint and a water bottom reflection time;

determining a rate of change of the water bottom reflection time of each trace;

generating a model water velocity and a model water bottom reflection time for each trace midpoint using a preselected function of the water bottom reflection times and the rates of change; and

generating a plurality of water bottom reflection time corrections for each trace group using a pre-selected function of the water bottom reflection times, the model water bottom reflection times, the model water velocities, and the trace offsets.

2. The method of claim 1, wherein selecting the plurality of trace groups comprises selecting a plurality of trace groups expected to have approximately a common water velocity.

3. The method of claim 1, wherein selecting the plurality of trace groups comprises selecting a plurality of trace groups having a common cross-line group.

4. The method of claim 1, wherein determining the rate of change of the water bottom reflection time of each trace comprises determining the rate of change of the water bottom reflection time of each trace using the trace offset, the trace water bottom reflection time, and an estimated water velocity associated with the trace midpoint.

5. The method of claim 1, wherein determining the rate of change of the water bottom reflection time of each trace comprises determining the rate of change the water bottom reflection time of each trace with respect to the water velocity.

6. The method of claim 1, wherein determining the rate of change of the water bottom reflection time of each trace comprises determining the rate of change of the water bottom reflection time of each trace using an approximate analytic expression for the rate of change.

7. The method of claim 1, wherein generating the model water velocity and the model water bottom reflection time for each trace midpoint using the preselected function of the water bottom reflection times, the estimated water velocities, and the rates of change comprises minimizing a least-squares function of the water bottom reflection times, the estimated water velocities, and the rates of change.

8. The method of claim 1, wherein generating the plurality of water bottom reflection time corrections for the trace groups using the pre-selected function comprises generating the plurality of water bottom reflection time corrections for the trace groups using a least-squares error function.

9. The method of claim 8, wherein generating the plurality of water bottom reflection time corrections for the trace groups using the least-squares error function comprises minimizing the least-squares error function.

10. The method of claim 8, wherein minimizing the least-squares error function comprises minimizing the least-squares error function using at least one of a Gauss-Seidel method and a conjugate gradient method.

11. The method of claim 1, wherein generating the plurality of water bottom reflection time corrections comprises determining a plurality of zero-offset water bottom reflection time corrections, each zero-offset water bottom reflection time correction being associated with one of the trace groups.

12. The method of claim 1, wherein generating the plurality of model water bottom reflection times comprises generating a plurality of zero-offset model water bottom reflection times.

13. The method of claim 1, further comprising forming a plurality of updated water bottom reflection times using the plurality of water bottom reflection time corrections and the plurality of model water bottom reflection times.

14. The method of claim 13, further comprising generating a plurality of new water bottom reflection time corrections using the pre-selected function of the water bottom reflection times, the updated water bottom reflection times, and the trace offsets.

15. The method of claim 13, wherein forming the updated water bottom reflection times comprises forming a plurality of updated zero-offset water bottom reflection times.

16. An article comprising one or more machine-readable storage media containing instructions that when executed enable a computer to:

select a plurality of trace groups from traces collected along a plurality of sail lines in a marine seismic survey area, each trace having an offset from a midpoint and a water bottom reflection time;

determine a rate of change of the water bottom reflection time of each trace using the trace offset, the trace water bottom reflection time, and an estimated water velocity associated with the trace midpoint, the rate of change being taken with respect to the water velocity;

generate a model water velocity and a model water bottom reflection time for each trace midpoint using a preselected function of the water bottom reflection times, the estimated water velocities, and the rates of change; and

generate a plurality of water bottom reflection time corrections for each trace group using a pre-selected function of the water bottom reflection times, the model water bottom reflection times, the model water velocities, and the trace offsets.

17. The article of claim 16, wherein the one or more machine-readable storage media contain instructions that when executed enable the computer to determine the rate of change of the water bottom reflection time of each trace using an approximate analytic expression for the rate of change.

18. The article of claim 16, wherein the one or more machine-readable storage media contain instructions that when executed enable the computer to generate the model water velocity and the model water bottom reflection time for each trace midpoint by minimizing a least-squares function of the rate of change, the water bottom reflection time, and the estimated water velocity.

19. The article of claim 16, wherein the one or more machine-readable storage media contain instructions that when executed enable the computer to generate the plurality of water bottom reflection time corrections for the trace groups using a least-squares error function.

20. The article of claim 19, wherein the one or more machine-readable storage media contain instructions that when executed enable the computer to generate the plurality of water bottom reflection time corrections for the trace groups by minimizing the least-squares error function using at least one of a Gauss-Seidel method and a conjugate gradient method.

21. The method of claim 16, wherein the one or more machine-readable storage media contain instructions that when executed further enable the computer to form a plurality of updated water bottom reflection times using the plurality of water bottom reflection time corrections and the plurality of model water bottom reflection times.

22. The method of claim 21, wherein the one or more machine-readable storage media contain instructions that when executed further enable the computer to generate a plurality of new water bottom reflection time corrections for each of the traces in the trace groups using the pre-selected function of the model water bottom reflection times, the updated water bottom reflection times , and the offset.

23. The method of claim 16, wherein generating a plurality of water bottom reflection time corrections comprises generating a plurality of zero-offset water bottom reflection time corrections.

24 . An article comprising one or more machine-readable storage media containing data structures and data formed by:

selecting a plurality of trace groups from traces collected along a plurality of sail lines in a marine seismic survey area, each trace having an offset from a midpoint and a water bottom reflection time;

determining a rate of change of the water bottom reflection time of each trace using the trace offset, the trace water bottom reflection time, and an estimated water velocity associated with the trace midpoint, the rate of change being taken with respect to the water velocity;

generating a model water velocity and a model water bottom reflection time for each trace midpoint using a preselected function of the water bottom reflection times, the estimated water velocities, and the rates of change; and

generating a plurality of water bottom reflection time corrections for each trace group using a pre-selected function of the water bottom reflection times, the model water bottom reflection times, the model water velocities, and the trace offsets.

25. The article of claim 24, wherein determining the rate of change of the water bottom reflection time of each trace comprises determining the rate of change of the water bottom reflection time using an approximate analytic expression for the rate of change.

26. The article of claim 24, wherein generating the plurality of water bottom reflection time corrections for the trace groups comprises the plurality of water bottom reflection time corrections for the trace groups using a least-squares error function.

27. The article of claim 26, wherein generating the plurality of water bottom reflection time corrections for the trace groups comprises minimizing the least-squares error function using at least one of a Gauss-Seidel method and a conjugate gradient method.

28. The article of claim 24, wherein the data structures and data are further formed by updating the water bottom reflection times using the plurality of water bottom reflection time corrections for each trace group to the traces in each group.

29. The article of claim 28, wherein the data structures and data are further formed by generating a plurality of new water bottom reflection time corrections for each of the traces in the trace groups using the pre-selected function of the water bottom reflection times, the updated water bottom reflection times, and the offsets.

30. The article of claim 24, wherein generating the plurality of water bottom reflection time corrections comprises generating a plurality of zero-offset water bottom reflection time corrections.